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THE THREATENED RICHMOND BIRDWING BUTTERFLY (*ORNITHOPTERA RICHMONDIA* [GRAY]): A COMMUNITY CONSERVATION PROJECT

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Abstract

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Destruction of coastal rainforests in south-eastern Queensland and north-eastern New South Wales has led to extinction of *O. richmondia* from two-thirds of its original range and a sharp decline in surviving populations. The species is further threatened by depletion of the butterfly's lowland food plant, *Pararistolochia praevenosa*, and by presence and spread of the Dutchman's Pipe vine, *Aristolochia elegans*, which attracts oviposition but the leaves are toxic to larvae when they attempt to feed. Originally from South America, Dutchman's Pipe has spread from garden cultivation into national parks and reserves. Above 800 m on the Queensland/NSW Border Ranges, *P. laheyana*, also supports birdwing larvae. However, these populations are subject to periodic extinctions, probably due to climatic stress at the higher altitudes where re-colonisation is thought to be dependent on immigrants from lowland populations. Community groups and state national parks authorities are participating in projects to conserve the Richmond birdwing butterfly. The CSIRO's Double Helix Science Club is co-ordinating studies on *P. praevenosa* by students at more than 130 schools, where growth and phenology of 12 vines at each school are being monitored to understand the butterfly's host plant interactions. Aspects of biology of the butterfly and its food plants and strategies which have a bearing on its conservation are discussed.

Introduction

The Richmond birdwing butterfly, *Ornithoptera richmondia* (Gray) has been sometimes treated as a subspecies of the widely distributed, tropical *O. priamus* (Linn.) (Haugum and Low, 1978–1979), or as a distinct species (Zeuner, 1943; D'Abrera, 1975; Common and Waterhouse, 1981) based on its distribution, differences in the male genitalia and sterility of offspring when hybridised with *O. euphorion* (Gray). However, recent reports (A. Hiller, pers. comm.) indicate that these hybrids are not always sterile. Hancock (1983) placed *O. richmondia* in a *priamus* species-group in the genus *Troides* Hubner, subgenus *Ornithoptera*, but subsequently (Hancock, 1991) validated *Ornithoptera* as a separate genus.

Adults of both sexes are similar to *O. euphorion*, although *O. richmondia* is smaller (wingspan of males c. 12–14 cm; females c. 14–16 cm). Adults emerging in spring are often smaller than those emerging in summer and autumn (Common and Waterhouse, 1981), a characteristic attributable to loss of mass in the overwintering pupa. Poor quality of food plants following drought also leads to reduced size in the developing individuals. In males, the green and the gold spots on the upperside of *O. richmondia* are more restricted than in *O. euphorion* and variable in extent. Haugum and Low (1978–1979) described *richmondia reducta*, with areas of green further reduced, from Grafton and elsewhere. However, this variation is not confined to the southern range of *O. richmondia* indicating that *reducta* is not a valid subspecies. A blue male of *O. richmondia* has been sighted (B. Davies, pers. comm.), a rare colour form also known in *O. euphorion* (R. Magarey, pers. comm.). Blue males which superficially resemble *O. priamus urvillianus* Guérin-Méneville from New Ireland and the Solomon Islands, result from an unusual distribution of the blue and gold scales present in males.

The abundance and distribution of *O. richmondia* have declined since the turn of the century (Illidge, 1927) following destruction of subtropical rainforest supporting *Pararistolochia praevenosa* (F. Muell.) M.J. Parsons (Aristolochiaceae), the principal food plant for its larvae. Originally distributed from Maryborough, south-eastern Queensland to Grafton,

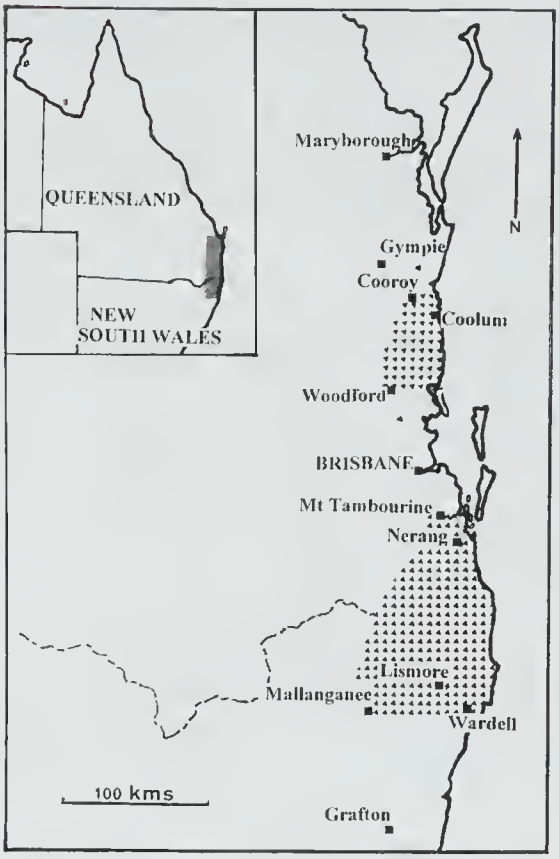

Figure 1. Map showing the distribution (shaded) of *Ornithoptera richmondia in 1995.*

north-eastern New South Wales (Haugum and Low, 1978–1979), the vine and sustained breeding colonies of *O. richmondia* have become extinct from about two thirds of the former northern, central and central parts of its range (Fig. 1). In south-eastern Queensland *O. richmondia* still occurs locally from Yandina to Mt Mee and from Mount Tamborine to the NSW border. An isolated pocket has been observed near Kin Kin. In NSW, the species occurs from Wardell to the Queensland border wherever *P. praevenosa* survives in littoral and lowland rainforest remnants. On the Border and Nightcap Ranges, *O. richmondia* is abundant in the summer months most years where larvae feed on *P. laheyana* (F.M. Bailey) M.J. Parsons. A single female was once sighted near Coffs Harbour (R. Davis, pers. comm.) and one at Toowoomba (J. Macqueen, pers. comm.) in the 1960s but the food plants are not known from these areas.

O. richmondia was last seen near Mary River Heads in 1959 and at Rainbow Beach and Noosa about 1984 (unpubl.). Since the 1920s the butterfly has become rare near Brisbane (Illidge, 1927) where the food plants supporting the last breeding colonies were destroyed in the late 1980s. Occasionally ranging adults are seen and larvae have been recently observed on cultivated *P. praevenosa* close to Brisbane and at Mount Glorious (A. Hiller, pers. comm.). The last sightings of *O. richmondia* near Grafton, NSW were made at Susan Island about 45 years ago (J. Seymour/D. Landenberger, pers. comm). The food plant vines are referred to the genera *Aristolochia* and *Pararistolochia*, following revision of the Australian Aristolochiaceae by Parsons (1996).

Seasonality, biology and ecology

Ornithoptera richmondia is polyvoltine near the coast, adults appearing from late August until May but they are most abundant from September to November and February to April. Near Beewah, Queensland occasional sightings have been made in June and July (A. Powter, pers. comm.). At higher altitudes the species is univoltine with adults mostly appearing from November to February. In favourable years large numbers of adults migrate from the higher altitudes to the lowlands. Such phenomena were observed near Christmas Creek, Queensland in January 1994 and 1995 (M. Houston, pers. comm.) and at Limpinwood, NSW in January 1994 (N. Hepburn, pers. comm.).

The immature stages of *O. richmondia* were described by Common and Waterhouse (1981). The pale yellow eggs (diameter 2.3 mm x 2.0 mm deep, n = 4) are deposited usually singly on the underside of mature leaves of the food plant but occasionally on stems or other plants supporting the vines. Occasionally two or more may be deposited on preferred leaves but once 13 eggs were seen on a single leaf of *P. laheyana*. Young foliage utilised by 1st instar larvae is avoided by the ovipositing female. Eggs hatch in 9–13 days. After hatching larvae consume most of their eggshell and search (up to 2 days) for leaves of appropriate toughness. Instars 1–3 are black or dark purplish-brown with fleshy black spines on all segments except segment 4, which are bright yellow. Fourth and fifth instars may vary from black, brown through to creamish-grey, often with cream fleshy spines on segment 4. There are usually five instars or occasionally six when the nutritional quality of leaves utilised is low. The duration of larval development ranges from 27–46 days (n = 23). However, low nutritional quality of the food plant may also protract the rate of development of larvae. During ecdysis, larvae

spin a silken pad beneath a leaf of the food plant or other plant nearby and become torpid for 2–3 days.

Larvae usually leave the food plant to pupate. They select the underside of a leaf (e.g., *Wilkiea* spp., *Ficus coronata* Spin) over which they spin a large silken pad and strengthen the petiole with silk to prevent dislodgment during the protracted pupal phase. Pupae are attached by a cremaster and silken girdle and unlike other species in the genus, are bright green with yellow markings (Common and Waterhouse, 1981) and have an overwintering pupal diapause. In coastal populations most larvae pupating after the last week of January enter diapause and emerge in spring (127–275 days, n = 8) while larvae pupating in spring or early summer months emerge within 32–40 days without entering diapause.

Eggs of *O. richmondia* are preyed upon by several species of ants including *Iridomyrmex glaber* (Mayr) and *Pheidole megacephala* (Fab.) an assassin bug (Reduviidae) and the predatory bug, *Oechalia schellenbergia* (Guerin). They are especially susceptible to desiccation during periods of drought. Natural enemies of larvae (mainly instars 1–4) include spiders, the bull ant, *Myrmecia gulosa* (Fab.), the jumper ant, *M. nigrocincta* F. Smith, the soldier beetle, *Chauliognathus atricornis* (Lea)(Cantharidae) and viruses. Cannibalism amongst larvae (mainly instars 1–4) of *O. richmondia* during ecdysis is a major mortality factor. The pupae are occasionally attacked by unidentified hymenopterous parasitoids and when in diapause are subject to desiccation when accompanied by very low temperatures. A pied currawong was observed to peck a pupa but failed to eat it. Adults are sometimes trapped in spiders webs but are rarely attacked by other predators including birds (e.g., noisy pitta).

At high altitudes on the Border Ranges extinctions occur in some years, thought to result from desiccation and extremely low temperatures. These extinctions occur about every 3–7 years after which recolonisation is dependent on immigration from lowland populations.

Food plants of *O. richmondia*

Pararistolochia praevenosa is a locally-distributed vine in lowland, subtropical rainforest (< 600 m) on basaltic slopes, creek banks, or on volcanic alluvial soils bordering rivers and streams. Occasionally *A. praevenosa* occurs in sand dune loams overlying volcanic soils. The vine may ascend 20 m into the rainforest canopy. Large vines branch close to ground level, producing somewhat flattened mature stems bearing widely-spaced nodes with alternate leaves. On older plants stems sometimes emerge horizontally and layer, developing clumps of vines which climb vertically. Stems may be 1–2 cm in diameter, frequently fusing with other ascending stems. The bark has a distinctive raised, slender reticulated pattern which is easily recognisable at ground level. Vines grow throughout the year particularly after rain, the autumn and winter growth avoiding attack by the larvae of *O. richmondia*. The tough, lanceolate (base slightly cordate) leaf forms with twisted petioles are variable in size, those from alluvial soils tending to have smaller, narrower leaves (c.16 × 6 cm) than those from basaltic soils (> c. 22 × 10 cm). The flowers (September-November) are pollinated by midges (*Forcipomyia* spp.: Ceratopogonidae; G. Monteith, pers. comm.). The orange fruit when ripe (March-April) fall intact to the ground where they are dispersed by ground birds, particularly brush turkeys. Seeds are macerated and some buried by the feeding birds which results in the germination of clusters of seedlings.

Understorey vertical growth of *P. praevenosa* bearing young leaves is selected by ovipositing females and preferred by larvae while tall canopy growth is less frequently utilised. However, the quality of soft foliage of *P. praevenosa* acceptable to newly-eclosed larvae is limited since they exclusively require young, soft leaves near the apex of an actively growing vine. Even young leaves at the 6–8th node from the apex may be too tough to support feeding. While late 2nd and later instars will consume the firmer leaves, flowers, seeds and softer stems, 1st instar larvae survive only on sub-apical, expanding leaves and avoid the pubescent growing tip. On *P. praevenosa* when soft foliage is limited, larvae of *O. richmondia* prey on others undergoing ecdysis. Rarely will more than two larvae share leaves on the same stem without attacking one another. The pupae are also susceptible to cannibalism when larvae are deprived of sufficient soft foliage.

Experiments were carried out to determine the toughness of leaves of *P. praevenosa*, acceptable to newly-eclosed larvae of *O. richmondia*. Larvae were held in organza sleeves with leaves attached to plants, selected with progressively increasing toughness using a leaf penetrometer described by Sands and Brancatini (1991). These experiments showed that leaves exceed-

ing a toughness (force) of 0.23 newtons/mm^2 were too tough for first instar larvae and they starved without feeding. Thus, leaf toughness of *P. praevenosa* appears to contribute significantly to survival and abundance of *O. richmondia*. Leaf toughness of *P. praevenosa* was estimated to account for 85% of starvation by first instar larvae (n=183) between 1986 and 1988 at a breeding site.

In montane rainforest above 800 m, on the NSW, Queensland Border Ranges, larvae of *O. richmondia* feed on *P. laheyana*. This plant occurs as an understorey vine on basaltic ridge tops and occasionally slopes where it is much less robust than *P. praevenosa*. *P. laheyana* is a horizontal, as well as vertical climber rarely ascending more than 4 m. The smooth and slender stems (c. < 0.8 cm) frequently branch and bear small (c. 12 x 4 cm) leaves which are softer than *P. praevenosa* and most young growth is acceptable to first instar larvae. As larvae mature, leaves and the softer stems of *P. laheyana* may be consumed. Sometimes plants may be rendered leafless by gregarious larvae but they rapidly respond with growth when larvae are not present. Thus the equivalent biomass of *P. laheyana* has a greater carrying capacity for larvae than *P. praevenosa*, a factor believed to explain the greater abundance often observed at higher altitudes.

The larvae of *O. richmondia* will develop when fed from eclosion, on *Aristolochia tagala* Chamisso, a food plant for *O. euphorion* and several other birdwing butterflies Jebb (1993). However, eggs deposited on young leaves of this vine frequently fail to eclose. At the site of contact on a leaf, a raised necrotic patch of tissue develops, indicating a reaction by the plant to the egg or its accompanying secretions.

Adult *O. richmondia* visit the flowers on many different plants to gather nectar, preferring white and red blooms. *Ornithoptera* spp. and *Delias* spp. (Pieridae), comprise two of the few butterfly genera that visit flowers of red bottlebrush (*Callistemon* spp.). Native flowers favoured include *Syzygium* spp., *Eucalyptus* spp., *Lophostemon confertus* (R. Br.) Wilson and Waterhouse, *Flagellaria indica* L., *Melicope elleryana* (F. Muell.) T. Hartley, *Alloxylon pinnata* (Maiden and Betche) and *Grevillea* spp. as well as many exotic species.

Conservation program

Many fragile breeding habitats for *O. richmondia* continue to be destroyed despite community conservation efforts. At Coolum, the northern coastal limit on the Sunshine Coast, a breeding site was recently threatened by home unit development while another colony on the Nerang River may now be safe after intensive lobbying by a local conservation group. Pressures on populations from collectors of adult *O. richmondia* are negligible, provided that many immature stages are not removed from breeding sites. Bushfires destroyed several sites during November 1994 in an exceptionally dry season.

The ornamental Dutchman's Pipe vine, *Aristolochia elegans* Mast., originally from South America, attracts oviposition by *O. richmondia* but it is poisonous to the early instar larvae when they attempt to feed on its leaves (Straatman, 1962). This vine has escaped cultivation to become a weed in forestry reserves, national parks and many of the riverine habitats previously occupied by *P. praevenosa*. Egg counts made on both *A. elegans* and *P. praevenosa* in Burleigh Heads National Park showed a marked preference for the exotic species by the ovipositing butterflies. Between 1981and 1992 counts showed that eight times more eggs (n = 486) were deposited on *A. elegans* than on *P. praevenosa*. Most larvae attempting to feed on *A. elegans* died in the first instar but a few reached third instar. Fortunately the Dutchman's Pipe vine is easily eradicated. Over the last two summers an officer working in Burleigh Heads National Park has successfully controlled the vine, encouraging other authorities and community groups to undertake similar eradication programs. Widespread media publicity against growing and selling the vine has generally led to its removal from suburban gardens.

The conservation status of the Richmond birdwing is considered 'vulnerable' (IUCN category), although not previously classified by Collins and Morris (1985). A conservation strategy for the butterfly is underway based on cultivation of *P. praevenosa* in gardens, environmental reserves and schools. The project began in 1992, sponsored by the NSW National Parks and Wildlife Service. Balunyah Nursery at Coraki, NSW were provided with seedlings, cuttings and seeds of *P. praevenosa* enabling them to develop stocks of for distribution to other nurseries. To date more than 15 000 vines have been distributed to retailers and community groups participating in the program. Community participation expanded rapidly and in 1993 CSIRO's Science Education Program, the Double Helix Club was approached to co-ordinate the projects. By combining the scientific

and education expertise of officers from both Organisations, students began to participate in research and the conservation program.

The success of the program is reflected by the magnitude of community involvement. More than 130 schools between Grafton and Maryborough are currently involved in the project. Each school has planted 12 vines which will supplement the diminishing wild food plants and provide breeding corridors for areas without vines. Temperatures, rainfall and growth parameters of the vines are being measured as part of the coordinated Double Helix Club program. Schools will be evaluating a new leaf penetrometer, conducting experiments on the vines, and collecting and identifying insect pollinators from the flowers of *Pararistolochia* spp.. They assist with locating Dutchman's Pipe in bushland and provide community awareness and advice for removal of the vine from cultivation when it threatens the progeny of ovipositing *O. richmondia*. As well as educating for conservation, they are encouraging cultivation of *P. praevenosa* and have developed a strong sense of ownership towards protecting the butterfly.

Dispersing female *O. richmondia* have oviposited on cultivated vines at Alstonville, near Brisbane and at Beerwah, where urban environments do not appear to inhibit re-establishment of the butterflies. Queensland's first butterfly habitat reserve for the Richmond birdwing was designated at the Stanley River Rehabilitation Project, by the Queensland Department of Primary Industry and a Land Care group. The South Bank Corporation in the heart of Brisbane, has nominated 'Butterfly Island' for student and public education and planted the island with 30 *P. praevenosa*.

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